Raytheon
Integrated Defense Systems
Customer Success Is Our Mission

Model Driven Software Development, A Case Study The Good, the Bad and the Ugly

Gari Palmer
Senior Principal Software Engineer
Information Systems and Computing Technology Area
Director
May 18, 2011

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
18 MAY 2011		**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Model Driven Software Development, A Case Study The Good, the Bad and the Ugly	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Raytheon Company,Integrated Defense Systems,870 Winter Street,Waltham,MA, 02451-144**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
Presented at the 23rd Systems and Software Technology Conference (SSTC), 16-19 May 2011, Salt Lake City, UT. Sponsored in part by the USAF. U.S. Government or Federal Rights License

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**19**	

MDSD Case Study: Agenda

Raytheon
Integrated Defense Systems

- The Good, the Bad and the Ugly
- Model Driven Software Development – The Basics
- Case Study Scope and Method
- The Raytheon System
- The MDSD Components
- MDSD Summary Results
- MDSD Consultants
- Shortcomings of MDSD Program Use
- Advantages of MDSD Program Use
- New Technology Adoption Factors
- Towards a Culture of Change
- Suggested Improvements

The Good, The Bad, The Ugly

Raytheon
Integrated Defense Systems

- *The Good*
  - *–Model Driven Software Development (MDSD) reduced development time, staffing and cost*
- *The Bad*
  - *–Model Driven Software Development was not fully embraced by the development and integration teams*
- *The Ugly*
  - *–Model Driven Software Development has not gained the adoption we would like to see*

There are many sides to the MDSD story

Model Driven Software Development – The Basics (1 of 3)

Raytheon
Integrated Defense Systems

Traditional Software Development

Model Driven Software Development

Model Driven Software Development – The Basics (2 of 3)

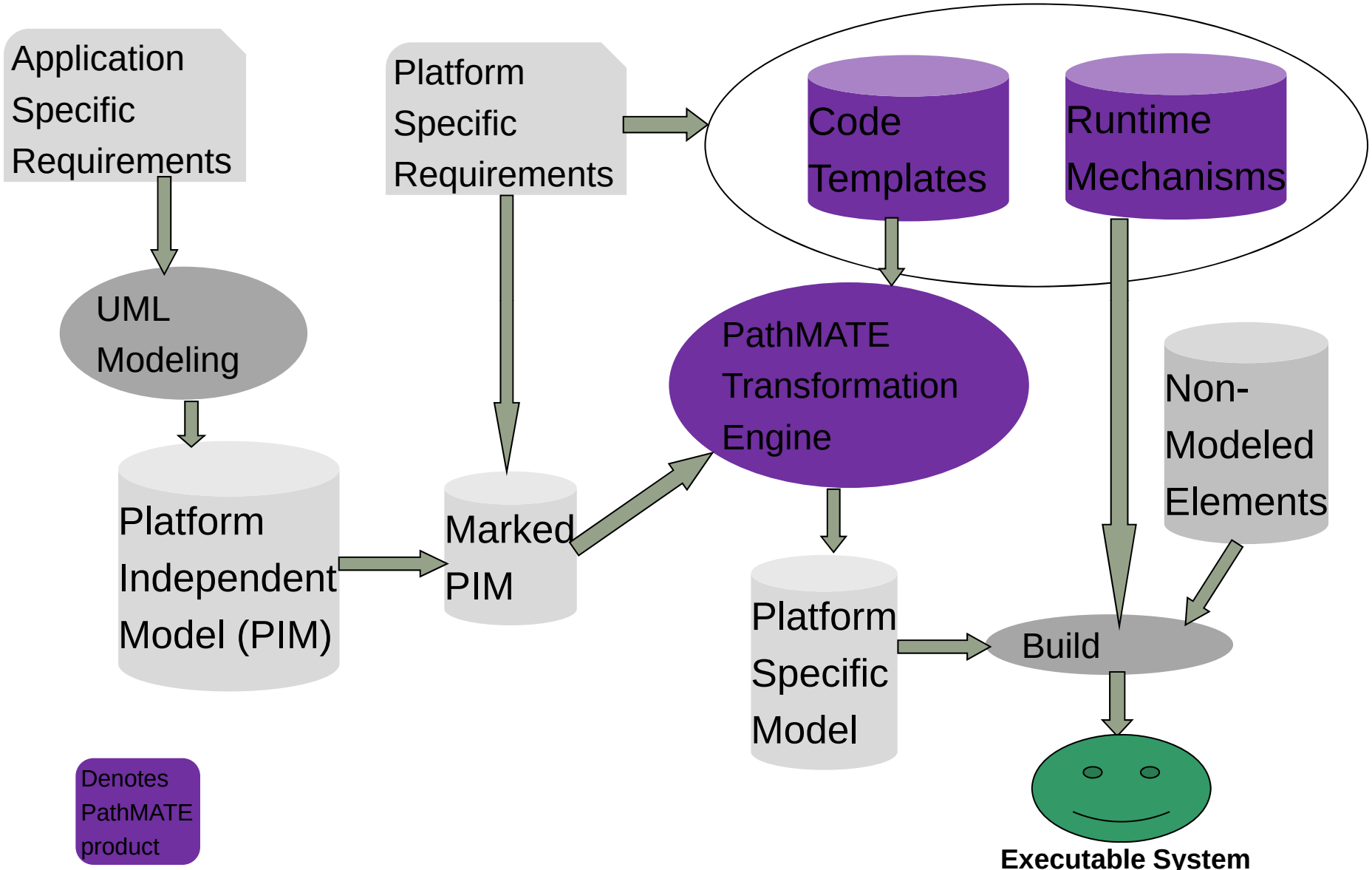
Raytheon
Integrated Defense Systems

- Model-Driven Software Development is the term used for defining systems, including behavior, in models, and then using the models to generate deliverable code
- Platform Independent Model (PIM) of an application's functionality and behavior
- Developers mark up the PIM with platform specific notations
- Models transformed to code using standardized mappings for specific target platforms (can be provided by mature tool such as PathMATE by Pathfinder Solutions)
- Models transformed to Software Design Document
- Design and code are always syncronized

MDSD raises the level of abstraction

Model Driven Software Development – The Basics (3 of 3)

Raytheon
Integrated Defense Systems



Case Study Scope and Method

Raytheon
Integrated Defense Systems

- Why:
  - Uncover the pros and cons of MDSD use on a program
  - Provide insight to how we can improve MDSD deployment
  - Communicate to engineers and managers
- What:
  - A retrospective of the deployment of MDSD on one Raytheon program
  - Interviews with 12 people:
    - Architects
    - Software Developers
    - Integrators
    - Program and Software management
  - Productivity and defect density metrics were collected from a Six Sigma project

Information in this presentation is from the interviewees and Six Sigma Report

The Raytheon System

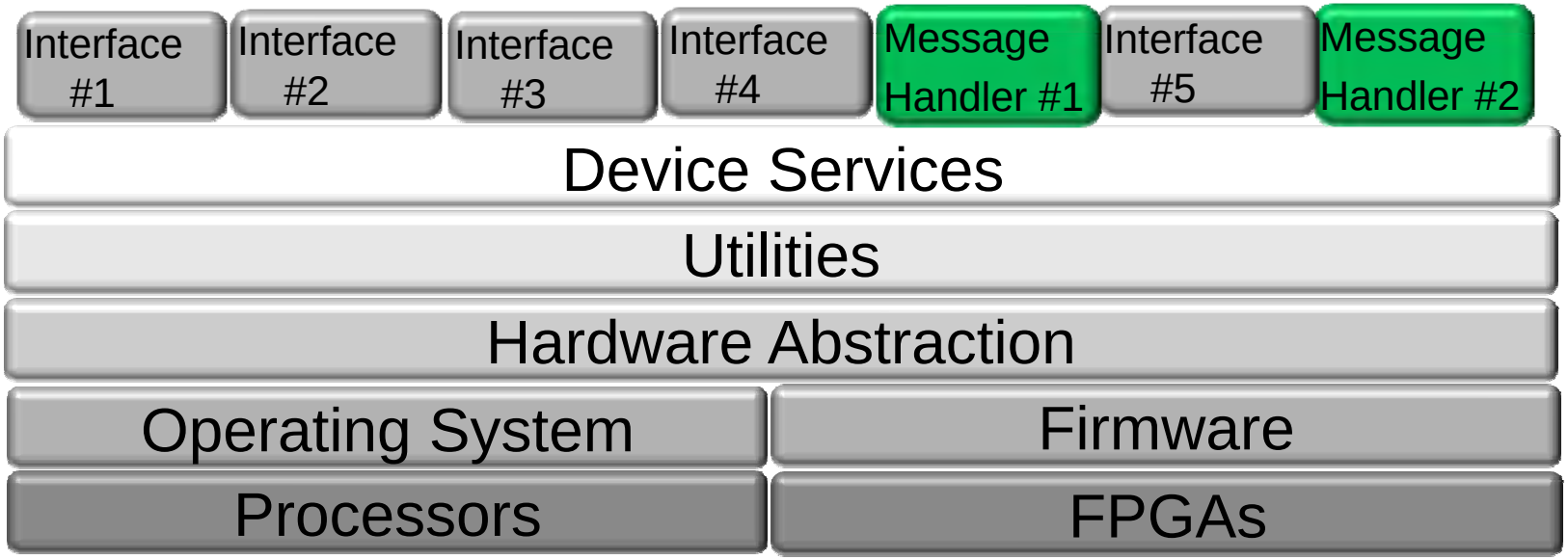
Raytheon
Integrated Defense Systems

- System Description:
  - A weapon system used against:
    - cruise missiles,
    - unmanned aerial vehicles (UAVs)
    - fixed –wing and rotary-wing aircraft
  - The system integrates surveillance, command and control, fire-direction, fire distribution and engagement capabilities
  - The system is currently delivered

The MDSD Components

Raytheon
Integrated Defense Systems

- The Communications Architecture. Two of the message handlers (in green) were generated with MDSD
- The existing interfaces were reused from another contract



MDSD Summary Results

Raytheon
Integrated Defense Systems

- Positives:
  - Generally considered a success by managers and engineers
  - The customer was extremely happy with working components developed under budget, on time with lower defect densities
  - Under ran budget
- Negatives:
  - Abstract development approach reduces understanding of system details
  - Harder to find the origin of a defect during integration
  - Extensive involvement from Pathfinder Solutions consultants

The Customer: **“**The Software Organization beat the budget – a refreshing change”

MDSD Summary Results Metrics

Raytheon
Integrated Defense Systems

- Calculation approach:
  - Raytheon measures for productivity and defect density are based on Source Lines of Code (SLOC)
  - MDSD code generation typically results in greater SLOC than traditional hand coding
  - MDSD generated SLOC count was decreased by 50% to normalize measures which reduces productivity and defect density results
  - MDSD Consultant costs and Developer training are embedded in Design, Code and Unit Test program costs
- Measures:
  - Planned for traditional coding approach. Only used **65%** of planned **developers**
  - Design, code, unit test and integration (DCTI**) productivity** for both Message Handlers was at least **44% greater** than standard
  - **Defect Density** (defects per KSLOC) was **1/3 business average**

MDSD Consultants

Raytheon
Integrated Defense Systems

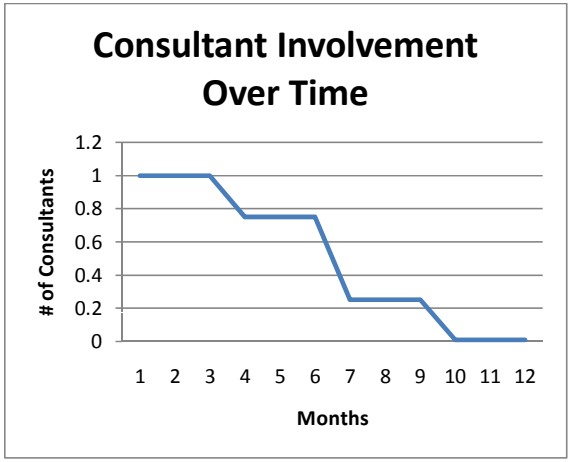
- Pathfinder Solutions (vendor of PathMATE) highly recommends the use of consultants to get a project off on the correct path

Pros:

- High caliber consultants
- Available for quick fixes to PathMATE (pro & con)
- Provided training and mentoring on architecture methodology, OO design and PathMATE specifics

Cons:

- If the tool were more stable, there was better documentation or Raytheon had more expertise, there would be less need for consultants
- Use of consultants side by side with developers calls productivity into question
- The use of consultants may not be scalable for deployment to Raytheon



Shortcomings of MDSD Program Use

Raytheon
Integrated Defense Systems

- Tool:
  - Debugging during integration is more complex
  - Need fairly extensive experience with the toolset to make it work properly
  - Training and mentoring was required for success when developers preferred to write code
  - Very simple changes may require knowledge of multiple tools rather than just a programming language and compiler
  - VxWorks integration was immature
- People:
  - Not all engineers adapt well to new methods and levels of abstraction
  - Hands-on training is best for comfort with new tools
  - Mentors must be available
  - MDSD is built on OO. Therefore, a solid OO foundation is beneficial
  - Lots of communication is required

Advantages of MDSD Program Use

Raytheon
Integrated Defense Systems

- Trivial task to make some global changes
  - Changed 72-word message format to and 80-word message format for hundreds of messages in **1.5 weeks**
- Application code generated by MDSD resulted in lower defect density
- Design and code are always in sync
- Method enforced common vocabulary and design guidelines
- Collaborative approach to architecture and design

Program Office Quote "The customer was so impressed that for a year the MDSD success was mentioned in their viewgraphs"

New Technology Adoption Factors

Raytheon
Integrated Defense Systems

- Risks and opportunities must be communicated
- The advantages and disadvantages must be communicated
- Expect challenges with technology when it is new to the development team
- Not every engineer is ready for the challenge
- Hands on training for all team members is key
- Mentors/consultants need to be available
- Must communicate successes (productivity and quality) to team

The Defense industry and it's partners are risk averse – we still need to make forward progress with new technologies

Towards a Culture of Change

Raytheon
Integrated Defense Systems

- At a Corporate level, Raytheon realizes that new technologies drive better productivity and products
- Raytheon has been adopting more technology-based development paradigms (Agile, Lean, MDSD, Domain Specific Languages, Software Factories)
- Raytheon software management respects and rewards technology adoption

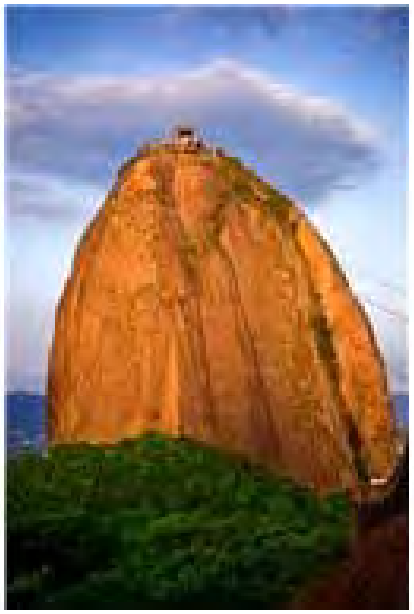
Suggested Improvements for Technology Deployment

Raytheon
Integrated Defense Systems

- Select teams based on their experience and willingness to engage with new technology
- Ensure effective training for all engineers no matter when they join the project
- Existing processes and measures do not always neatly map to new technologies. New processes and measures need to be incorporated to foster wider adoption
- Continue to investigate new MDSD tools and technologies
- Encourage engineers and managers to understand MDSD benefits and pitfalls
- Provide feedback on productivity, schedule and quality status to developers

Summary

Raytheon
Integrated Defense Systems



Methods → Tools → Training → Communication → SUCCESS

Acronyms

Raytheon
Integrated Defense Systems

- *MDSD – Model Driven Software Development*
- *OO – Object Oriented*
- *SLOC – Source Lines of Code*
- *UML – Unified Modeling Language*